REMARKS

Claims 1-5 and 7-19 remain in the application, claims 20 and 21 having been canceled. Reconsideration of the application and allowance of all claims are respectfully requested.

In addition to the cancellation of claims 20 and 21 and incorporation of their subject matter into claim 1, claim 1 has been amended to specify the thickness of the conductive support which is between 10^{-2} mm and 10^{-1} mm. Support for this amendment can be found at line 30 of page 4 of the application as filed.

The prior art rejections are respectfully traversed.

Kawano

Kawano discloses a non-sintered type nickel electrode comprising a metal plate or a metal foil, which is worked or formed into a corrugated shape (col.2, 1.43-47). The nickel electrode can be made by first preparing a paste comprising nickel hydroxide powder mixed with an aqueous solution of carboxymethylcellulose and styrene-butadiene rubber (col.4, 1.49). The resulting paste is then coated on the sides of each of the metal plates.

Contrary to the Examiner's argument at page 18 of the Office action applicant continues to maintain that Kawano's corrugated support is not a two dimensional conductive support.

Further, the apparent thicknesses of Kawano's corrugated electrodes are 150 μm, 180 μm, 300 μm and 600 μm (col.3 1.46).[1] These values are higher than the upper value of 100 μm (10^{-1} mm) now specified in claim 1.

Thus, Kawano does not disclose (1) a two dimensional support, (2) a binder which is a mixture of a cellulose and a styrene-acrylate copolymer, or (3) a thickness of the conductive support which is between 10^{-2} mm and 10^{-1} mm.

Bernard

Bernard discloses a secondary electrochemical cell with an alkaline electrolyte, comprising a negative electrode comprising an hydridable alloy whose surface is covered by a protective layer constituted by nickel hydroxide [0009], and a positive electrode.

Paragraph [0013] of Bernard teaches that the negative electrode comprises a conductive support which can be either a two-dimensional or a three-dimensional support, and a binder which is preferably selected from a styrene and butadiene copolymer and a styrene and acrylate copolymer. Paragraph [0014] of Bernard teaches that the positive electrode may be of the sintered type or it may include a foam support.

If the Bernard positive electrode is of the sintered type, it is different from the non-sintered electrode of the claim 1.

[1] Applicant notes that Kawano discloses a strip-like having a thickness of 60 μm. However, this thickness is given for a bare nickel plate, i.e., a nickel plate which is not yet coated with the active material.

On the other hand, if the positive electrode is of the type having a foam support, a foam support is a three-dimensional conductive support, as discussed in paragraph [03] at page 1 of the present application, and is different from the two-dimensional support recited in claim 1. Bernard in its general description does not give any value of thickness for either the negative electrode or the positive electrode. Further, the discussion of examples in Bernard discloses the use of a foam as a conductive support in both the positive and negative electrode. A foam is a three-dimensional support and not a two-dimensional support (see paragraphs [0049] and [0050] of Bernard), and its thickness is higher than 10^{-1} mm.

Thus, Bernard does not disclose (1) a positive non-sintered electrode comprising a substantially flat plane form two-dimensional conductive support, (2) a support having a thickness of between 10^{-2} mm and 10^{-1} mm, or (3) a binder which is a mixture of a cellulose compound and a styrene-acrylate copolymer.

Vandayburg

Vandayburg discloses a secondary electrochemical cell containing a positive electrode, a negative electrode, and an electrolyte which can be either an aqueous or non-aqueous electrolyte (col.6, 1.20-21), wherein at least one of the positive electrode and the negative electrode includes an electrode mixture containing an active electrode material and a binder, wherein the binder contains polyacrylamide and at least one copolymer selected from the group consisting of carboxylated styrene-butadiene copolymer and styrene-acrylate copolymer. (See, claim 1)

Vandayburg discloses a current collector which may be a thin metal foil, thus a two-dimensional current collector (col.5, 1.55). Vandayburg is silent regarding the thickness of the current collector. The electrode can be of the pasted type, i.e., non-sintered (col. 5, 1.51).

Vandayburg does not disclose a layer containing nickel hydroxide, a binder which is a mixture of a cellulose compound and a styrene-acrylate copolymer, or a two-dimensional conductive support having a thickness of between 10^{-2} mm and 10^{-1} mm.

Claim 1 is not obvious over Kawano in view of Bernard

Non-sintered electrodes having a three-dimensional conductive support such as felt or foam are known in the art, as discussed at page 1 of the present application. For reasons of cost, there is now a move towards the use of two-dimensional conductive supports. However, the known binders used to produce an electrode with a three-dimensional support prove unsuitable for a two-dimensional support, as described at page 2, lines 20-23 of the present application.

Further, binders for positive electrodes tend to degrade because they are exposed to the high potential of the positive electrode. Degradation of the binder does not occur at the negative electrode which operates at a lower potential than the positive electrode. Thus, there is a need for a binder which is suitable for a two-dimensional support and which withstands degradation caused by the exposition to a high potential.

The present invention solves this problem through the provision a specific binder which is a mixture of a cellulose compound and a styrene-acrylate copolymer. The electrode comprising the binder of the invention has a mechanical behavior and a mass capacity which

are at least equivalent to those of an electrode having a three-dimensional current-collecting support, as described at lines 3-6 of page 2 of the present application. The invention allows the fabrication of a positive electrode comprising a flat two-dimensional conductive support having a small thickness, i.e., between 10^{-2} mm and 10^{-1} mm. Although this electrode utilizes a thin conductive support, it exhibits a very good durability.

Kawano teaches that a nickel plate having a thickness of 150 μm (Sample "a" at the first row of Table I). The electrode comprising said nickel plate exhibits a utilization factor at cycle 3 of only 80.5%, and a utilization factor at cycle 5 of only 68.1% x 80.5% = 54.5%.

The electrode of Example II of the present invention utilizes a two-dimensional metal support which is a perforated nickel steel strip 50 μm thick. This electrode exhibits a utilization factor at cycle 11 of 245 mAh/g. This represents 97.5% of the theoretical capacity. The capacity obtained using the electrode of the invention is identical to that of an electrode comprising a foam conductive support. Example II thus shows that it is possible to prepare an electrode having a thinner conductive support which additionally exhibits a higher durability. This result thus shows an improvement of the mechanical behavior of the electrode in comparison with electrodes using a thicker conductive substrate.

This unexpected result is not suggested by Kawano. Indeed, Kawano indicates that the higher the apparent thickness the longer the lifetime of the cell. An analysis of Examples A-2, B-2, C-2 and D-2 shows that an apparent thickness of 150, 180, 300 and 600 μm, corresponds to utilization factors at the 3rd cycle of 81.7, 94.0, 95.2 and 96.3 %, respectively. The same conclusion can also be drawn from Examples A, B, C, D and A-3, B-3, C-3, D-3 (Table 2 and col.5, 1.45-47).

Further, Kawano teaches that it is not sufficient to corrugate the metal plate to obtain a good mechanical strength. It is also necessary to provide microscopic teeth at the surface of the metal plate (col. 5, lines 48-50, Fig.2A).

Thus, Kawano suggests neither the composition of the binder of the invention nor the possibility to have positive electrodes having a thin conductive plate.

Now turning to Bernard, even if the skilled person had prepared a mixture of a cellulose compound and a styrene-acrylate copolymer – which it is submitted would not have been obvious but can be assumed here for purposes of discussion - Bernard still fails to make obvious the newly added claim limitation of a thickness between 10^{-2} mm and 10^{-1} mm. The sole paragraph in Bernard disclosing a two-dimensional support is paragraph [0013]. However, there is no value mentioned or suggested. If the skilled person had considered the experimental section of Bernard he would have been led away from the invention. Indeed, the examples of Bernard teach a foam support, thus a 3D support whose thickness is higher than 10^{-1} mm ([0049] and [0050]).

Claim 1 is Not Obvious Over Kawano in view of Vandayburg

Even if the skilled person, considering Vandayburg, had prepared a mixture of a cellulose compound and a styrene-acrylate copolymer – again which is submitted would not have been obvious but can be assumed here for purposes of discussion - Vandayburg still fails to make obvious the newly added claim limitation of a thickness between 10^{-2} mm and 10^{-1} mm. There is no value mentioned or suggested.

Thus, the combination of Kawano and Vandayburg does not lead to the invention as now claimed.

Further, none of the other secondary references teach the newly added claim limitation of a thickness between 10^{-2} mm and 10^{-1} mm.

Thus, claim 1 is patentable over the prior art, and therefore all claims dependent therefrom are also patentable.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

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Respectfully submitted,

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